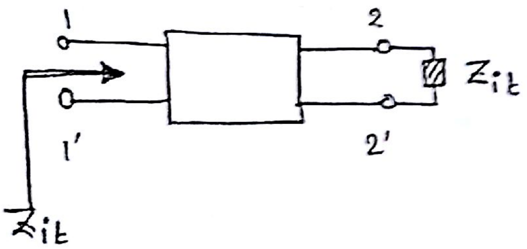
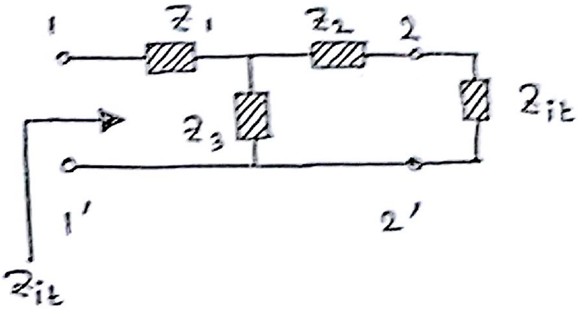
S.Q. ⊛

Iterative impedence :-

Defination :- The iterative impedence of a four-terminal linear network is that impedence which when connected to one pair of terminals of the network produces a like impedence at the other pair of terminals. It is denoted by Z_{it}.

Derivation // expression of Z_{it} :-





Let us consider a T network ckt. with an impedence Z_{it} connected 2 & 2' and then between 1 & 1' terminal an impedence equal to Z_{it} will be produced.

Hence, $$Z_{it} = \left[Z_1 + \frac{Z_3(Z_2+Z_{it})}{Z_3+Z_2+Z_{it}}\right]$$

or, $$\cancel{Z_{it}Z_3} + Z_{it}Z_2 + Z_{it}^2 = Z_1Z_3 + Z_1Z_2 + Z_1Z_{it} + Z_2Z_3 + \cancel{Z_3Z_{it}}$$

or, $$Z_{it}^2 + Z_{it}(Z_2 - Z_1) - (Z_1Z_2 + Z_2Z_3 + Z_3Z_1) = 0$$

$$\therefore Z_{it} = \frac{-(Z_2-Z_1) \pm \sqrt{(Z_2-Z_1)^2 + 4Z^2}}{2}$$

where, $Z^2 = Z_1Z_2 + Z_2Z_3 + Z_3Z_1$

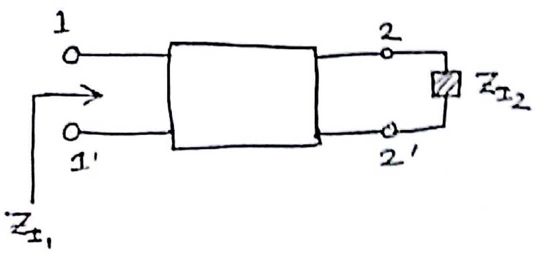
or, $$\boxed{Z_{it} = \frac{(Z_1-Z_2)}{2} \pm \sqrt{\left(\frac{Z_1-Z_2}{2}\right)^2 + Z^2}} \Rightarrow (1)$$

For symmetric T network ; $Z_1 = Z_2$

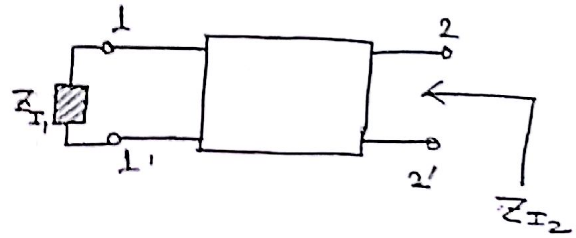
$$Z_{it} = \pm\sqrt{Z^2} = \pm\sqrt{Z_1Z_2 + Z_2Z_3 + Z_3Z_1}$$

Image Impedence :-

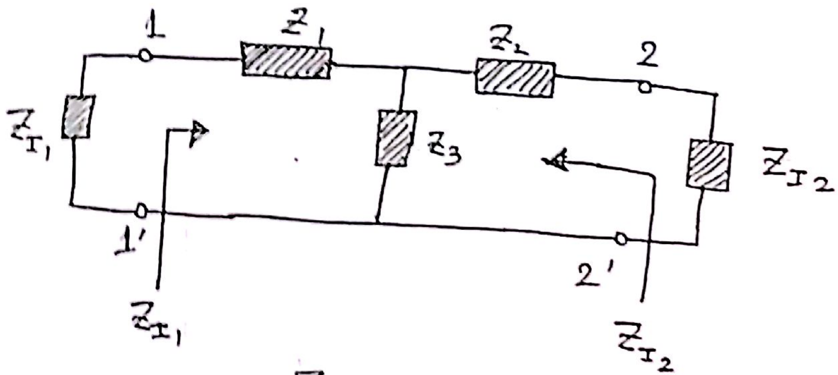
The image impedence pair of a four terminal linear network is such a pair of impedences that when, one impedence of the pair terminates the output port of the network, The input impedence at the input port would be equal to the other impedence of the pair . The Reverse is also true . This pair is denoted by Z_{I_1}, Z_{I_2} .



or,



equivalent network :-



from fig,

$$Z_{I_1} = \left[Z_1 + \frac{Z_3(Z_2 + Z_{I_2})}{(Z_3 + Z_2 + Z_{I_2})}\right] \quad \text{and} \quad Z_{I_2} = \left[Z_2 + \frac{Z_3(Z_1 + Z_{I_1})}{(Z_3 + Z_1 + Z_{I_1})}\right]$$

$$Z + [Z_3 \,||\, (Z_2 + Z_{I_2})]$$

Solving we can write,

$$Z_{I_1} = \sqrt{\left(\frac{Z_1 + Z_3}{Z_2 + Z_3}\right)(Z_1Z_2 + Z_2Z_3 + Z_3Z_1)} \quad \text{and}$$

$$Z_{I_2} = \sqrt{\left(\frac{Z_2 + Z_3}{Z_1 + Z_3}\right)(Z_1Z_2 + Z_2Z_3 + Z_3Z_1)}$$

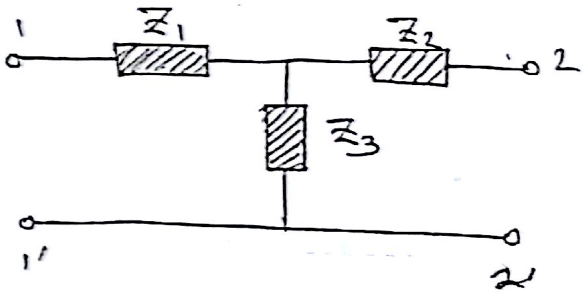
For symmetric T network $Z_1 = Z_2$

$$\therefore Z_{I_1} = Z_{I_2} = \sqrt{(Z_1Z_2 + Z_2Z_3 + Z_3Z_1)} = \underline{\underline{Z_{it}}}$$

i.e., for symmetric Network Image & Iterative impedence are equal. This impedance is termed as characteristics impedence of symmetric T-network. It is denoted by

$$Z_0 = \sqrt{(Z_1Z_2 + Z_2Z_3 + Z_3Z_1)}$$

Expression of Z_{I_1} & Z_{I_2} in terms of Z_{01}, Z_{S1}, Z_{02} and Z_{S2} :-



$$Z_{01} = Z_1 + Z_3 \; ; \; Z_{S1} = \left[Z_1 + \frac{Z_2Z_3}{Z_2+Z_3}\right]$$

$$Z_{02} = Z_2 + Z_3$$

$$Z_{S2} = \left[Z_2 + \frac{Z_1Z_3}{Z_1+Z_3}\right] = \frac{Z_1Z_2 + Z_2Z_3 + Z_3Z_1}{Z_1+Z_3}$$

$$Z_{I_1} = \sqrt{\left(\frac{Z_1+Z_3}{Z_2+Z_3}\right)(Z_1Z_2 + Z_2Z_3 + Z_3Z_1)}$$

$$= \sqrt{Z_{01} \cdot Z_{S1}}$$

Similarly, $$Z_{I_2} = \sqrt{\frac{(Z_2+Z_3)}{(Z_1+Z_3)}(Z_1Z_2 + Z_2Z_3 + Z_3Z_1)}$$

$$= \sqrt{Z_{02} \cdot Z_{S2}}$$

This are the expression for any unknown network